

EXHIBIT 26

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Switchport Backup Interface:Software Functional Specification:EDCS-328530



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Switchport Backup Interface

Software Functional Specification

This document describes the functional behavior of “switchport backup interface” feature. This feature will be supported on DSBU switches.

Reviewers

Department	Name/Title
Development Engineering	
Dev/Test Engineering	
Manufacturing	

The departments and/or individuals listed above should be notified in advance and given a sufficient time period to review this document. The Project Team determines requirements for approval according to the scope of the project.

Modification History

Rev.	Date	Originator	Comment
0.1	10/23/2003	Murali Duvvury	Initial Draft
1.0	12/15/2003	Lucern K. Ma	
2.0	08/23/2003	Rohit Sharma	Added section for Backup Interface Pre-emption

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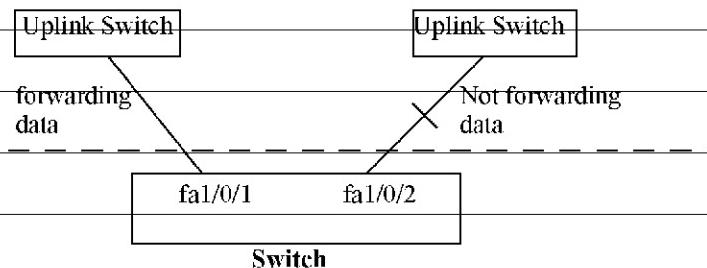
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1.0 Problem Definition

Switchport Backup interface feature allows users to configure one of the L2 interfaces (Physical port or Agport) to backup another L2 interface. The two interfaces provide mutual backup to each other, i.e., Only one of the interfaces forwards traffic. The other one is in backup mode which is not forwarding traffic and is ready to take over in case the forwarding interface is down. The interface that is forwarding traffic is called as "Active interface" and the interface that is backing up is called as "Backup interface".

When the Active interface goes down, the backup interface takes over as Active and starts forwarding traffic. Later when the original Active interface comes back up, it may preempt the current Active interface depending upon the pre-emption mode configured by the user. If pre-emption mode is off, this interface will go into Backup mode. User can also configure the pre-emption mode to always force a switchover to the configured active, or to switchover to higher available bandwidth interface.



In this example, interface fa1/0/2 is backing up interface fa1/0/1. The two links fa1/0/1 and fa1/0/2 are connected to uplink switches. Only one of the interfaces is forwarding traffic and the other one is in standby mode.

For example in the above figure, fa1/0/2 is configured to backup fa1/0/1. Initially fa1/0/1 is forwarding traffic and fa1/0/2 is in backup mode not forwarding traffic. When fa1/0/1 goes down, fa1/0/2 takes over and starts forwarding traffic.

This feature provides an alternate solution that allows to turn off STP and still get basic link redundancy. This feature is typically configured in those Service Provider/Enterprise environments where customers do not want to run STP on the switch. When STP is running on the switch, there is no need to enable this feature since STP already provides link level redundancy/backup. Even though it is not a requirement to coexist this feature with STP, there are no explicit checks that prevent users from configuring this feature along with STP.

This feature is a Layer 2 feature and is supported only on L2 physical ports or Agports, not on L3 ports.

The convergence time from Active->Backup interface switchover will be in the range of 100 msec for LOTR and PLXAR platforms, and in the range of 1-2 sec for Vegas platform. Traffic loss timing for the pre-emption switchover, is similar to traffic loss for the case when an active interface goes down and the backup interface takes over.

There are some restrictions:

- Only one interface can be configured as back up interface for a given Active interface.
- An interface can be configured as back up interface for only one Active interface.
- An Active interface can not be a back up interface for another Active interface and similarly a backup interface can not be an Active interface for another backup interface.
- Active interface cannot be the same interface as the backup interface.
- Both Active interface and backup interface cannot be a member of an Agport.

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2.0 Functional Behavior

The following sections describe the functional behavior of various sequences

2.1 Configure Active and Backup Interface

To configure backup interface, user has to issue “switchport backup interface” interface configuration command. For example,

```
switch#conf t
switch(conf) # int fa1/0/1
switch(conf if) # switchport backup interface fa1/0/2
switch(conf-if) #
```

The above commands configure fa1/0/2 as the backup interface for interface fa1/0/1. These two interfaces provide mutual backup to each other.

Initially fa1/0/1 is forwarding traffic and fa1/0/2 is in backup mode ready to take over in case the Active interface (fa1/0/1) goes down.

When the ‘switchport backup interface’ command is executed,

- If the configured Active interface (fa1/0/1) is up and running, the backup interface (fa1/0/2) goes into backup mode.
- If the configured Active interface (fa1/0/1) is down, the backup interface (fa1/0/2) immediately takes over as Active and starts forwarding traffic
- If both the configured Active interface (fa1/0/1) and backup interface (fa1/0/2) are down, whichever interface comes up later will be the Active starts forwarding traffic and the other one will be the backup. If the backup interface comes up as well, their roles will be resolved based on the pre-emption scheme configured by the user.

2.2 When the Active interface goes down

If there is a backup interface:

- Flush the MAC addresses learnt on the previously forwarding interface (this should happen automatically, because of link down)
- Enable Backup interface to start forwarding traffic
- Send Mac-address Move Update packets on the backup interface for fast bi-directional traffic convergence
- Send Dummy Multicast packets on the backup interface for fast bi-directional traffic convergence
- Initiate an IGMP Global Leave on all ports, similar to what happens during TCN (Topology Change Notification)
- Generate a TRAP to inform NMS stations about the change. No new MIB will be defined. Existing LinkUp/LinkDown trap is used.

2.3 When the Backup Interface goes down

If the backup interface goes down:

- Notify the users about backup interface not available, by sending a TRAP.
- There is no change to the Active interface, it continues to forward traffic, except there is no

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backup available.

2.4 When original Active interface comes back up

When the original Active interface goes down, the configured Backup interface takes over and starts forwarding traffic. Later, when the original Active interface comes back up, it may preempt the Backup interface, depending upon the pre-emption scheme configured by the user:

- If the configured pre-emption mode is Off, original Active interface then starts backing up the Backup interface by not forwarding traffic, and is ready to take over when the Backup goes down.
- If the configured pre-emption mode is Forced, original Active interface will then preempt the current Backup interface after a user-specified pre-emption delay.
- If the configured pre-emption mode is Bandwidth and the available bandwidth of the original Active interface is more than that of Backup interface, original Active interface will then preempt the Backup interface after a user-specified pre-emption delay.
- If the configured pre-emption mode is Bandwidth and the available bandwidth of the original Active interface is less than or same as that of Backup interface, original Active interface then starts backing up the Backup interface by not forwarding traffic, and is ready to take over when the Backup goes down.

Note

The pre-emption delay value for a backup interface pair is used to accommodate the STP forwarding delay time on the neighbor switch interface. By default, this value is 35 seconds.

2.5 While Active interface is forwarding traffic, Backup interface comes up

When a backup interface comes up while Active interface is currently forwarding traffic, it may preempt the Active interface, depending upon the pre-emption scheme configured by the user. The pre-emption logic is same as stated in section 2.4.

2.6 While Active interface is forwarding traffic, Backup interface available bandwidth changes

When the Backup interface's available bandwidth changes while Active interface is currently forwarding traffic:

- If the configured pre-emption mode is Bandwidth and the available bandwidth of the Backup interface is more than that of current Active interface, Backup interface will then preempt the current Active interface after a user-specified pre-emption delay.
- If the configured pre-emption mode is Bandwidth and the available bandwidth of the Backup interface is less than or same as that of Active interface, Backup interface continues backing up the current Active interface by not forwarding traffic, and is ready to take over when the Active goes down.

2.7 While Active interface is forwarding traffic, Active interface available bandwidth changes

When the Active interface's available bandwidth changes while Active interface is currently forwarding traffic:

- If the configured pre-emption mode is Bandwidth and the available bandwidth of the Active interface becomes less than that of current Backup interface, Backup interface will then preempt the current Active interface after a user-specified pre-emption delay.
- If the configured pre-emption mode is Bandwidth and the available bandwidth of the Active interface becomes more than or equal to that of current Backup interface, Backup interface continues backing up

the current Active interface by not forwarding traffic, and is ready to take over when the Active goes down.

3.0 Feature Interactions

This section describes interactions of Backup interface feature with other features

3.1 STP interaction

It is not a requirement currently to coexist STP and Backup interface features together on a switch. But there is no restrictions to the users from configuring both of them together. If the user chooses to run STP with the feature, both the Active and backup interface will not participate in the STP in all valid VLANs.

3.2 Etherchannel

This feature can't be configured to backup individual members of etherchannels, nor can an individual member of etherchannels be backed up by another interface. However, the users can choose to backup the whole channel group with another interface, which can also be a channel group interface.

3.3 Port Security

All of the functionalities of Port Security are preserved with Backup Interface.

3.4 UDLD

Backup Interface feature does not have any impact on the functionalities of UDLD. The behavior expected is the same as before.

4.0 Memory and Performance Impact

There should not be any major memory and performance impact with the addition of Backup Interface feature.

5.0 Packaging Considerations

This feature will be packaged as a separate sub-system under sys/switch directory, that can be easily added by other switch platforms (Cat4k/6k).

6.0 End User Interface

6.1 switchport backup interface

```
switch(conf-if)# switchport backup interface <interface name>
```

This command is an interface configuration command. It configures the backup interface pair.

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6.2 switchport backup interface pre-emption

switchport backup interface <interface_name> pre-emption {forced|bandwidth|off}

switchport backup interface <interface_name> pre-emption {delay <1-300>}

This command is an interface configuration command.

It configures pre-emption scheme for the backup interface pair.

Three pre-emption modes are available:

forced : Configured Active interface always pre-empts Backup

bandwidth : Higher available bandwidth interface always takes over

off : No pre-emption occurs from Backup to Active

Default pre-emption mode is Off, where backup interface only takes over when active interface goes down.

Example:

switch(conf-if)# switchport backup interface <interface_name> pre-emption off

Once a decision for backup interface pair pre-emption is made, Pre-emption occurs after a delay time (in seconds) configured by the user. Default pre-emption delay value is 35 seconds.

Example:

switch(conf-if)# switchport backup interface <interface_name> pre-emption delay 10

6.3 show interface switchport backup

switch# show interface switchport backup

This command will display the configured Active<->Backup interface pairs and their state.

An example of the display format is:

Switch Backup Interface Pairs:

Active Interface	Backup Interface	State
Fa1/0/1	Fa1/0/2	Active Up/Backup Standby
Fa3/0/1	Fa4/0/1	Active Down/Backup Up
Po1	Po2	Active Standby/Backup Up

6.4 show interface switchport backup detail

switch# show interface switchport backup detail

This command will display in detail, administrative and operational parameters for the backup interface pairs.

An example of the display format is:

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Interface Pair : Fa1/0/1 (Up), Fa1/0/2 (Standby)
Pre-emption mode : forced
Pre-emption delay : 35 seconds (default)
Bandwidth : 1000 Mbps (Fa1/0/1), 100 Mbps (Fa1/0/2)
Mac-Address Move Update Vlan (admin) : none
Mac-Address Move Update Vlan (oper) : 25

7.0 Configuration and Restrictions

- The “switchport backup interface” command is available only for L2 ports
- This command can be executed either on Physical L2 ports which are not part of any etherchannels or on the Agports (channel groups).

8.0 Testing Considerations

<body>

9.0 Patentability Considerations

<body>

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References

Glossary

CLI	Command Line Interface
LOTR	Lord of the Rings, first release of stackable Layer 2/3 switch
STP	Spanning-Tree Protocol

Review Action Items

Switchport Backup Interface Function Specification Changes Review Meeting Minutes

10:30-12:00, 1 Sep 2005, SJ-19/2, Sleepers

Attendees

Jim Maples, Lucern Ma, Mandar Joshi, Rohit Sharma, Gokul Tirumalai(offline)

Comments

- Section 1.0: mention the pre-emption modes in the second paragraph.
- Section 1.0: remove the last line from the paragraph explaining the figure.
- Section 1.0: mention traffic-loss during pre-emption switchover.
- Section 1.0: Restrictions: add a bullet saying an interface can backup only one active interface.
- Section 2.4: mention pre-emption delay may be set corresponding to the forwarding STP delay on the neighbor.
- Section 3.2: reword to indicate a FEC can be backed up by another FEC interface.
- Section 4.0: remove reference to LOTR and let the comment be generic.
- Section 6.2: split the sample CLI into two - one for mode and other for delay.
- Section 6.2: use the limits for delay to be <1-300> seconds.
- Section 6.2: mention again that default pre-emption mode is Off.
- Section 6.2: <auto> seems a good keyword for the mode where the switch automatically computes which link to preempt. We can add <auto> to the existing parse chain once we have identified more factors than bandwidth alone. We still need to keep the <bandwidth> keyword explicitly.
- Section 6.4: try to improve readability of the <show interface switchport backup detail> CLI.
- Section 6.4: if the pre-emption delay is 35 seconds, indicate (default) in the output.
- Section Glossary: Include the used abbreviations.

Attachments

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